



PIER Energy-Related Environmental Research

Environmental Impacts of Energy Generation, Distribution and Use

Global Warming and Breeding in Migratory Birds: Utilizing an Undervalued Historic Database

Contract #: 500-02-004; UC MR-069; MEX-07-06

Contractor: Stanford University

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Match Funding: \$50,000, Winslow Foundation

Contractor Project Manager: Terry L. Root

Commission Project Manager: Gina Barkalow

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The Issue

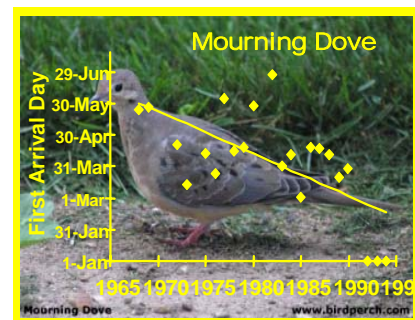
Wild plants and animals on all continents are exhibiting discernible changes in response to rapid regional climatic change. For example, in the upper peninsula of Michigan, Mourning Doves returned progressively earlier from 1965 to 1990, and after 1990 the climate was warm enough for this species to stay year-round and stop migrating (see plot at right). For many North American birds, the timing of spring migration has gotten progressively earlier over the last few decades.

Earlier migration may cause other events, such as nest building and egg hatching, to occur earlier. This “phenological cascade” of various sequential events happening earlier could affect the rest of the ecosystem. As the planet continues warming rapidly, this might be a concern, because the faster the climate and related phenologies change, the higher the risk of trouble, such as the decoupling of predator-prey relationships.

Project Description

This project—funded by PIER’s Exploratory Environmental Grants Program—involves two steps: (1) investigating how closely the timing of egg laying by birds migrating to California is tied to temperature, and (2) examining how the timing of egg laying is related to departure times in the autumn. This will enhance our understanding of the role temperature plays in the breeding of migrant birds and if that role influences their autumn departure dates.

The study will use a largely ignored data source: museum egg collections, which provide laying dates from the latter part of the 19th century through the 1930s. This was a time when the atmospheric concentrations of both carbon dioxide (CO₂) and methane (CH₄)—two of the most important greenhouse gases—were still relatively low. Average global temperatures from ~1860



As regional temperatures have risen, Mourning Doves have returned to Michigan’s upper peninsula earlier each year. Such shifts in the timing of migration could have cascading effects on other species in migratory bird ecosystems.

to ~1920 had a lot of variability but the trend was fairly flat. From ~1920 to ~1940 temperatures increased, but then flattened again from ~1940 to ~1975, after which temperatures have been increasing rapidly. Comparing the historic egg data with more recent breeding data provides an unparalleled time series for examining the association between temperature and time of breeding.

These springtime associations will be compared to modern information from the late 20th century (no historical data are available) about the autumn migration departure date. This comparison will indicate if changing spring phenologies appear to cascade into changes in autumn phenologies.

The information obtained in this study will serve as a basis to:

1. Determine the spatial and temporal availability of egg/nest data for several California bird species.
2. Develop a method needed to assess the timing of breeding from egg collections, including a measure of uncertainty/error.
3. Derive species-specific historical windows of breeding phenology in California, including spatial variability and interannual temporal variability for selected species.
4. Compare the historical timing of breeding with recent (late 20th century) data on breeding phenology.
5. Help answer questions about breeding patterns such as: How old are the juveniles when they migrate? Are they consistently getting younger, consistently getting older, or remaining roughly the same age?

This study will help better define future research needs in this field by:

- Providing critical baseline data to evaluate whether phenological changes induced by global warming can be linked across seasons.
- Being the first such investigation in North America.
- Exploring a unique and untapped dataset on bird breeding phenology.
- Assessing multi-site datasets on breeding phenology to determine if they will provide fundamental ecological data on California songbird species that can be used in further investigations of climatic change as well as other ornithological studies.
- Breaking new policy ground in that the availability of breeding information as far back as 100 years will allow the research team to predict much more robustly the possible future ecological consequences for a suite of possible temperature increases.

The methods developed for this project will undoubtedly be applicable to egg collections worldwide, given that almost all large natural history museums have egg collections but very few have the data computerized as of yet. Innovative analysis of these egg data could encourage others to computerize their data, as well as provide methods of analysis.

PIER Program Objectives and Anticipated Benefits for California

This project offers numerous benefits and meets the following PIER program objective:

- **Evaluate environmental effects of energy production, delivery, and use.** This research will allow forecasts of ecological consequences due to rapid climate warming. For example, suppose one of the bird species examined is a voracious predator of a pest that eats California crops. If the population of the avian predator drops significantly, then the pest could reproduce unchecked. Greater understanding of potential negative consequences may further raise public awareness of the dangers of greenhouse gas emissions.

Final Report

PIER-EA staff intend to post the final report on the Energy Commission website in fall 2008 and will list the website link here.

Contact

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